

Radiographic Analysis of Neutral Zone In Relation to the Crest of the Alveolar Ridge

Prashanth Shetty¹ Shweta Hegde² Vinod KS^{3*} Mohammed Tahir⁴ Preeti Yadav⁵ Mimansha Patel⁶

¹Professor and Head, Department of Prosthodontics, Triveni Institute of Dental Sciences, Bilaspur, Chhattisgarh, India.

²Reader, Department of Oral and Maxillofacial Radiology, Triveni Institute of Dental Sciences, Bilaspur, Chhattisgarh, India.

³Reader, Department of Oral and Maxillofacial Pathology, Triveni Institute of Dental Sciences, Bilaspur, Chhattisgarh, India.

⁴Assistant Professor, Department of Prosthodontics, RUHS College of Dental Sciences, Jaipur, Rajasthan, India.

⁵Senior Lecturer, Department of Prosthodontics, NIMS University dental college, Jaipur, Rajasthan, India.

⁶Senior Lecturer, Department of Oral and Maxillofacial Pathology, Triveni Institute of Dental Sciences, Bilaspur, Chhattisgarh, India.

ABSTRACT

Background and Aim: The very idea of creating an artificial denture in an edentulous patient is based on various parameters surrounding the orofacial region. The positioning of the teeth on the alveolar ridge depends on several factors and the "neutral zone" is one of the prime among them. The present study was aimed at recording the location of neutral zone and its relationship to the crest of the alveolar ridge in relation to the period of edentulousness (Less or more than one year duration). After recording the neutral zone in the mandibular arch using low fusing greenstick compound, two different gauges of wire 30 and 28 were adapted on the crest of the alveolar ridge and on the centre of the physiologically moulded greenstick compound respectively. An occlusal radiograph of the recording base and the cast was made and the radiographic images of both the wires were correlated followed by a statistical analysis. The study showed that the position of the neutral zone in relation to the crest of the alveolar ridge was found to be highly affected by the period of edentulousness ($p= 0.001$). The longer the period of edentulousness, the more buccally or labially the neutral zone was located.

Keywords: Neutral zone, Crest of the ridge, Period of edentulousness, Occlusal radiograph.

INTRODUCTION

Neutral zone concept plays an important role in developing quality denture prosthesis. The goal of dentistry is to keep all the teeth of an individual in health and in comfort throughout his life. If however, teeth are lost despite all efforts to save them, the prosthesis should be fabricated in such a manner so as to function efficiently and comfortably in harmony with the muscles of the stomatognathic system and the temporomandibular joints.^{1,2} Prosthodontic treatment in complete denture construction is influenced by the concept 'Form follows function'.^{3,4} The prosthodontist

should consider this basic law of physiology while constructing complete dentures and take into consideration the unique functioning of individual patient's musculature.^{5,6} This is accomplished by utilizing the Neutral Zone Concept. Neutral Zone is the zone of minimum conflict, where during function, the forces of the tongue pressing outward are neutralized by the forces of the cheeks and lips pressing inward.^{7,8} When the dentures are not placed in the neutral zone they may be displaced each time the tongue and lips function. The denture like the tooth is a rigid body but act as a single unit. In denture construction the ultimate problem in maintaining the health of the stomatognathic

Received: Feb. 16, 2014; Accepted: May. 18, 2014

*Correspondence Dr. Vinod KS.

Department of Oral and Maxillofacial Pathology,
Triveni Institute of Dental Sciences, Bilaspur, Chhattisgarh, India.

Email: drvinodks09@gmail.com

system is one of harmonious distribution of pressure and failure to recognize significance of muscle function frequently resulting in unstable denture. The primary function of the concept of neutral zone is the application, distribution and dissipation of the pressure from the lips, cheeks and tongue.^{9,10} In view of the importance of neutral zone in complete denture construction, it is thought feasible to determine the relation between the centre of the alveolar ridge crest in relation to the neutral zone in a buccolingual direction. This will help in positioning of the teeth in a region of minimum conflict so that the stability of the denture is enhanced. An investigation was therefore planned to find a correlation if any between the period of edentulousness and the position of the neutral zone in relation to the ridge crest amongst the completely edentulous population of Bilaspur, Chhattisgarh.

METHOD

The position of the neutral zone to alveolar ridge was investigated in 30 edentulous patients comprising of males and female patients who reported to the department of Prosthodontics in Triveni Institute of Health Sciences, Hospital and Research Centre, in Bilaspur district of Chhattisgarh state, India. The patients were divided into two groups:

Group I consisted of 15 patients who were edentulous for a period of less than 1 year.

Group II included 15 patients who were edentulous for more than 1 year. The period of edentulousness of patients included varied from 1 year to 10 years. The radiographic assessment of the position of neutral zone to residual ridge was done in the following manner.

Preparation of record base:

Mandibular master cast was obtained from the zinc oxide eugenol (DPI Impression paste) secondary impression after beading and boxing. The base of the cast was made parallel to the residual ridge with the help of a model trimmer. The record base was made with autopolymerizing resin (Rapid repair, Dentsply India, Gurgoan) by sprinkle on method. The record base were then tried in the patient's mouth and was checked for comfort, retention, stability and extension.

Locating the neutral zone of the mandibular arch with softened green stick compound.

Low fusing greenstick compound (Tracing Sticks, DPI Pinnacle, Mumbai, India) was softened in a hot water bath (65^o Celsius). Generally one half of three fourths of the length of the green stick was sufficient for the lower jaw. The softened compound was kneaded and a roll was formed. The softened compound was placed on the mandibular record base. The tray was held in the left hand, one end of the green stick compound was seared in the flame of a bunsen burner. This end was then placed on the tray at the left retromolar pad and the compound was shaped and fitted on to the tray along the crest of the record base. Posteriorly the height of the compound rim was kept at 2/3rd the height of the retromolar pad. A small amount of the compound was manipulated along the labial, buccal and lingual slopes. The attached roll of compound was reheated in the water bath before carrying into the patient's mouth. Patient's lips were lubricated with petrolatum jelly. The tray with the softened modelling compound was rotated into the mouth and carefully seated. Care was taken so that the lips do not press against the compound until it was completely seated. A cup of warm water was given to the patient and instructed to sip and swallow several times in a pursing motion (Figure 1). During function of the lips, cheeks and tongue the forces exerted on the softened compound moulds it into the neutral zone. After the compound is cooled the recording base with the compound, rim was taken out of the mouth. If initially excessive amount of compound is used, it will be forced upward above the normal height of the occlusal plane. A sharp knife was used to reduce the height of the compound rim to the level of two third the height of the retromolar pad and the corners of the mouth. The compound is re-softened in hot water bath and second moulding is carried out. This remoulding is carried out several times until a stable base is achieved. The stability of the rim is tested by asking the patient to open the mouth wide, wet the lips with the tongue, count from 1 to 10 and say exaggerated 'Ohs', 'ahs' and 'ees'. If these movements raise the rim, the lack of stability must be caused by improper moulding of the compound which was placed on a stable base. The rim is placed back in hot water until the material is softened. The body moulding procedure is repeated and tested

until a stable rim is achieved (figure 2). The lower denture base with the neutral zone recording was then carefully carried out of the mouth and kept safely.

Radiographic assessment of neutral zone

On the final mandibular cast, a groove was cut along the crest of the ridge for about 1mm depth using a straight fissure bur. A 30 gauge stainless steel wire was adapted along the centre of the alveolar ridge on the bed of this groove. The wire was luted in this position with commercial glue. The recording base was then repositioned on the final cast. The occlusal surface of the compound rim was made parallel to the base of the cast. A 28 gauge stainless steel wire was adapted on the occlusal surface of the compound occlusal rim and later imbedded along the centre of the entire length of occlusal rim. Now an occlusal view radiograph of the recording base was taken, so that the radiographic images of both the wires were obtained (Figure 3). The source to object distance was standardised at 12 cms and the central ray was directed at the centre of the cast. Exposure parameters used were 70 kVp, 8mA, 20 impulses, 1 second exposure time. All the films were developed in an automatic processor. Each film was examined for the relationship between the images of these two wires in a buccolingual direction. If the two images of the wires coincided, a zero score was assigned. buccal or labial location of neutral zone wire with respect to the wire indicating the centre of the ridge in the anterior, premolar and molar region was assigned a positive value. A negative value was assigned for lingual location of neutral zone wire. The location of the neutral zone to alveolar ridge was measured in five different locations viz., the anterior, premolar and molar in the left and right region. In this manner 30 samples were obtained. Statistical analysis was carried out using the student 'T' test.

Formula used for student 'T' test –

$$T_{d.f} = \frac{(X1-X2)}{(S.E)}$$

Where

X1= Mean of Group I

X2= Mean of Group II

d.f = degree of freedom = $n_1 + n_2 - 2$

S.E = Standard error = $\sqrt{(n_1 - 1)}$

σ_1 = standard deviation of 1st group

σ_2 = standard deviation of 2nd group

n_1 & n_2 are sample numbers in each group

RESULTS

The basic data collected from 30 patients to correlate the position of the neutral zone in relation to the crest of the ridge is presented in Tables I to III. The patients were classified according to their period of edentulousness into two groups. The first group was edentulous for less than 1 year and the second group was edentulous for more than 1 year.

Table I: Shows the position of the neutral zone to the crest of the alveolar ridge in 5 different locations for patient's edentulousness for less than one year. In 31 locations (41.3 %) the neutral zone was located lingual to the crest of the ridge. In 28 locations (37.4%) the neutral zone was located buccally or labially. In 16 locations (21.3%) the neutral zone coincided with the crest of the alveolar ridge. The neutral zone was found to be located slightly lingual to the crest of the ridge by a mean ranging from (- 0.53 to 0.20) in the molar region (- 0.50 to -0.03) in the premolar region and -0.63 in the anterior region.

Table II: Shows the position of the neutral zone to the crest of the alveolar ridge for patients edentulous for more than 1 year. In 7 locations (9.3%) the neutral zone was located lingual to the crest of the ridge. In 54 locations (72%) the neutral zone was located buccally or labially. In 14 locations (18.7%) neutral zone coincided with the crest of the alveolar ridge. This group showed marked buccal or labial position of the neutral zone to the crest of the residual alveolar ridge by a mean ranging from (1.17 to 1.50) in the molar region, (1.03 to 1.80) in the premolar region and 0.73 in the anterior region.

Table III: Showed a significant correlation between the position of the neutral zone and the period of edentulousness (p=0.001).

The table III shows a highly significant deviation ranging from p = (0.01 + 0.001) in the premolar

Table 1: Position of the neutral zone to the crest of the alveolar ridge in five different location in group I.

No of subjects	Period of edentulousness in months (decimetre)	Left molar region	Left premolar region	Anterior	Right molar region	Right premolar region
1.	0.3	-2	-2	-2.5	-2	-2.5
2.	0.3	-2.5	-2	-2	-2	-1.5
3.	0.4	-2	-1.5	-3	-3.5	-2.5
4.	0.5	-2.5	+1.5	-3	0	+1
5.	0.6	-2.5	-2.5	+1	+1	0.5
6.	0.6	-2	-2	-0.5	+1.5	0
7.	0.6	0	-1.5	+1	-0.5	+1
8.	0.8	+1.5	-1	0	+1	0
9.	0.8	-2	+2.5	+2	+2.5	0
10.	0.9	+2	0	-1	+1.5	0
11.	0.10	0	-0.5	-1.5	0	0.5
12.	1	+2	-1.5	0	+2	+1
13.	1	0	+1	+1	0.5	+1
14.	1	+2	+1	-1	0	+1
15.	1	0	+1	0	+1	0
Mean	0.64	-0.53	-0.5	-0.63	0.2	-0.03
SD	1.53	1.80	1.49	1.55	1.65	1.20

Table 2: Position of the Neutral zone to the crest of the alveolar ridge in five different location in Group II.

No of subject	Period of edentulousness in months (decimetre)	Left molar	Left premolar	Anterior	Right molar	Right Premolar
1.	1.5	+1	-1.5	0	+1	+2
2.	1.5	-1	0	+1	+1	0
3.	2	+1	-0.5	+1	0	-0.5
4.	2	0	+2	0	0	+2
5.	2	0	+0.5	+1	-1	+1
6.	2	+1	0	-1.5	+1	+2
7.	4	+3.5	+2	+0.5	+2.5	+2.5
8.	4	+1	+2	+3	+3.5	+3
9.	5	-2	+1	+1.5	+2	+2
10.	6	+3.5	+2.5	0	+2.5	+2
11.	7	+2	+2	+1.5	0	+1
12.	8	+2	0	+1	+2.5	+3
13.	8	+2	0	+0.5	+2	+2
14.	8	+1.5	+2	+1.5	+2.5	+2.5
15.	10	+2	+3.5	0	+3	+2.5
Mean	4.73	1.17	1.03	0.73	1.50	1.80
SD	2.91	1.50	1.37	1.82	1.32	1.01

Table 3: Means, standard deviations and statistical significance between all groups.

	I year		More than 1 year		t	p
	Mean	STD	Mean	STD		
Left Molar	-0.53	1.80	1.17	1.50	2.82	0.01
Left Premolar	-0.50	1.49	1.03	1.37	2.96	0.01
Anterior	-0.63	1.55	0.73	1.02	2.85	0.008
Right molar	0.20	1.65	1.50	1.32	2.38	0.024
Right Premolar	-0.03	1.20	1.80	1.01	4.51	0.001
Period of edentulousness	0.64	1.53	4.73	2.91	5.38	0.001



Fig 1: Patient performing pursing, sucking and swallowing movements.

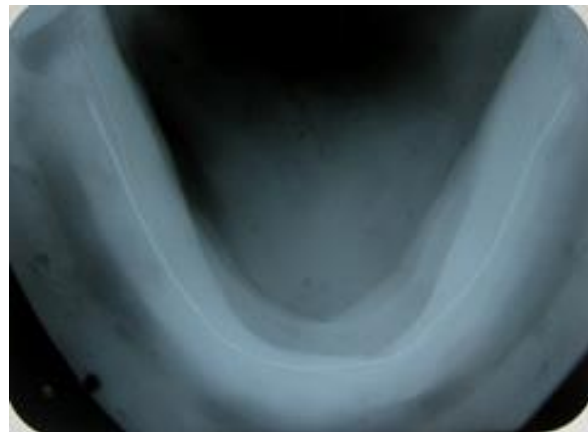


Fig 3: Occlusal radiographic view demonstrating the relation of the wires adapted on the centre of the compound rim and the crest of the ridge.



Fig 2: Compound rim moulded to neutral zone – labial view.

region. The table also shows significant deviation ranging from $p = (0.024 \text{ to } 0.01)$ in the molar region. In the anterior region the table shows a significant deviation of $p = 0.008$. The position of the neutral zone with respect to the crest of the alveolar ridge for the first group in different locations viz the anterior, premolar and molar region in the left and right are summarized in Table I.

All measurements were in millimeters, 0 Neutral zone coincides with the crest of alveolar ridge, + Neutral zone is buccal or labial with respect to crest of alveolar ridge, and - Neutral zone is lingually located with respect to crest of alveolar ridge.

A statistical analysis was undertaken between the two groups for different locations. The data was analysed statistically by students't' test. The mean values, standard deviation, and degree of significance are shown in Table III.

DISCUSSION

The concept of neutral zone plays an important role in complete denture fabrication.^{11,12} The need for studying the neutral zone was stressed as early as 1954 by Earl Pound.¹³ The present study attempts to relate the position of the neutral zone to the crest of the ridge in a buccolingual direction and its relation to the period of edentulousness.^{14,15} For many years prosthodontists have been trying to find out the ideal location of the teeth during complete denture fabrication. Literature is abundant with references that advocate the need for positioning the teeth in the neutral zone. In spite of its usefulness there are not many investigations which attempt to locate the neutral zone to lower ridge and correlate it with the period of edentulousness which may guide the placement of teeth. Keeping this in mind, this study was conducted to ascertain the position of the neutral zone in relation to the crest of the ridge by a radiological method. The neutral zone varies from person to person depending on the musculature and the resorption pattern. The method used in this study would be beneficial in these instances to locate the ridge neutral zone relation. The result obtained from this study on patients with a edentulous period of less than one year showed the neutral zone to be located lingually by a mean of -0.63 mm in the anterior region (table I). It indicates the need to place the mandibular anterior teeth more lingually in patients who are edentulous for less than one year. This finding is in agreement with the study conducted by Murray C¹⁶. The neutral zone in the anterior region was found to be labially located by a mean of +0.073 mm in patients who were edentulous for more than 1 year (table II). This means that the neutral zone was located slightly labial to the crest of the ridge. Accordingly, the anterior teeth should be positioned slightly labial to the crest of the ridge for patients who are edentulous for more than one year. However phonetic and esthetics should be considered while settling anterior teeth. Fahmi F.M also arrived at a similar conclusion from his study in 1990⁹.

The neutral zone in posterior region in patients who were edentulous for more than 1 year was found to be located more buccally by a mean ranging from 1.17 to 1.50 (Table II). Findings of Wright showed that if the size of the mandibular

teeth is too large (buccolingually) or if the posterior teeth are set even 1mm lingually the tongue is deprived of approximately 1000mm³ of its functional space. This can force the tongue into an abnormally retracted position. In addition, the transformation from the dentulous to edentulous state causes one tenth increase in tongue size. He indicated that the mandibular denture would receive more tongue pressure as a result of this increase in size. These factors should be considered while placing posterior teeth in dentures. The location of neutral zone assists in these instances for the correct placement of posterior teeth.^{17,18} This study also showed that the position of the neutral zone in relation to the alveolar ridge was found to be highly affected by the period of edentulousness, $p = 0.001$. The longer the period of edentulousness the more buccally or labially located was the neutral zone. Thus, this study brings to light the importance of the period of edentulousness and its usefulness in the arrangements of teeth. During the placement of teeth consideration must be given to the structural losses and changes that take place due to resorption. After the loss of natural teeth the maxillary ridge apparently moves lingually and mandibular ridge move buccally.

The mandible also usually exhibits atrophy to a much greater extent than the maxilla. As a result of which, there is decrease in the denture bearing area buccally and labially in the mandibular ridge. The neutral zone approach registers the zone of minimum conflict to determine the proper placement of teeth after resorption has taken place.^{19,20,21} In the absence of neutral zone principle the location of teeth are purely arbitrary. The awareness of neutral zone has been given importance due to increased risk of instability of the lower denture.

The standard approach of placing the artificial teeth on the crest of the ridge is not in any means true to the original location of natural teeth. In other words, one should not be dogmatic in insisting teeth be always placed over the crest of the ridge or lingual to the crest of the ridge to obtain a favourable ridge relation. The placement of teeth should be dictated by the lingual and buccal musculature which will vary from patient to patient.

8,10,18,21

CONCLUSION

From the results of the foregoing study, the following conclusions have been drawn:

In patients with history of less than 1 year of edentulousness; the neutral zone was located slightly lingual to the crest of the ridge.

The position of the neutral zone was situated buccal or labial to the crest of the ridge in subjects with an edentulous history of more than 1 year.

The position of the neutral zone in relation to the alveolar ridge was found to be highly affected by the period of edentulousness ($p=0.001$). The longer the period of edentulousness the more buccal or labial was the location of neutral zone. This observation is beneficial during the arrangement of posterior teeth for complete dentures. Since neutral zone serves as a guide it is suggested that the period of edentulousness should be considered while arranging the posterior teeth for complete dentures.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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